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ABSTRACT

This report summarizes four components of a research program. In the major investigation (Study 1), a method was developed for making bimodal presentations of discrepant auditory and visual stimuli under conditions which approximately early academic tasks. The goals were to determine (1) which stimulus modality exerts the greater influence on a young child's behavior, (2) whether modality choice is related to developmental level, and (3) what factors facilitate modality shifts. Study 2 was designed to answer some of the questions raised by the results of Study 1. Procedures were modified to allow evaluation of the influence of modality set and task difficulty and to control for stimulus novelty. In addition, the method was adapted for use with younger (3-year-old) children. In study 3, the responses of autistic children to the bimodal conflict task were evaluated. The transition from cardboard display boards and paper-and-pencil recording to the automated assessment console was begun in Study 4. (Author/CK)

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FINAL REPORT

Title of Project: Responsive Assessment of Socio-COgnitive Development
O-I-054 (OEG 9-70-0029 057)

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This report will summarize four components of the research program. In the major investigation (Study 1), a method was developed for making bimodal presentations of discrepant auditory and visual stimuli under conditions which approximate early academic tasks. The goals were to determine (a) which stimulus modality exerts the greater influence on a young child's behavior; (b) whether modality choice is related to developmental level; and (3) what factors facilitate modality shifts.

Study 2 was designed to answer some of the questions raised by the results of Study 1. Procedures were modified to allow evaluation of the influence of modality set and task difficulty and to control for stimulus novelty. In addition, the method was adapted for use with younger (3-year-old) children.

In Study 3, the responses of autistic children to the bimodal conflict task were evaluated. The transition from cardboard display boards and paper-and-pencil recording to the automated assessment console was begun in Study 4. Each of these studies is described below.

STUDY 1

In this initial study, a method was developed for assessing a young child's response to discrepant auditory and visual information (Bimodal Conflict). The Ss were 99 4- and 5-year-old children, mostly from low-income homes.

The child was taught a simple match-to-sample (MTS) task. Three colored pictures of people, animals or common objects were mounted across the bottom of a display board. These pictures were the comparison stimuli, and the child's task was to pick the one that matched the sample picture mounted at the top of the board. The child also learned to match to an auditory stimulus. On some trials a tape recorded sound or verbal label was substituted for the visual sample, and again the child was to choose the comparison stimulus that matched. After the child learned to match to either a visual or an auditory sample, discrepant stimuli were presented simultaneously. For example, he might hear the word "dog," see a picture of a cat in the sample position, and then have to choose between a dog, a cat and perhaps an airplane. After initial modality preferences were ascertained, priming and instructions were used to facilitate shifts to the nonpreferred modality.

The majority of the older Ss matched to the visual standard initially, while most of the younger Ss chose auditory matches. Unimodal priming was more effective in increasing shifts to the auditory than to the visual mode, and children who had already shifted modalities once were better able to ignore a competing auditory stimulus and shift to the visual mode than were children who made no prior shift. The results were discussed in the context of developmental changes in (a)

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susceptibility to "auditory capture" and (b) malleability of "task set."

A detailed report of the complete study is appended. A shorter version will appear in the Proceedings of the American Psychological Association (1972, in press).

STUDY 2

In the initial study, children were presented with the bimodal conflict task immediately after practicing visual MTS items. One possible explanation of the tendency of the older children to make initial visual choices is that they are more responsive than their younger counterparts to experimentally-induced sets. In order to test the effects of modality set at these different age levels, and to separate this phenomenon from reference and "capture," half of each age group was introduced to the conflict task following auditory practice, while the other half received visual trials immediately prior to the conflict condition.

Another possible reason for the paucity of visual choices in the younger children was that the task required the matching of stimuli that were conceptually similar but not physically identical. For example, the sample might be a white fox terrier and the comparison picture a brown cocker spaniel. The difficulty of concept matches for 4-year-olds might have inhibited visual choices. In order to test this hypothesis, two levels of task difficulty were included, one using exact visual matches and the other using concept matches.

Another change was to substitute slides for the pictures used as visual samples in the initial study. Viewing magazine pictures is a relatively mundane acitivity for most children, whereas listening to recorded sounds and viewing slides may be somewhat more novel and interesting events. The intent was to equate the attractiveness of the auditory and the visual stimuli so that differential interest values would not be confounded with modality choices.

Adapting the task for younger children was another goal of this study. Can position responding, so prevalent at the toddler and preschool levels, be decreased through minor changes in the task materials and procedures? Can the difficulty level of the bimodal conflict task be decreased sufficiently to allow the establishment of a match-to-sample set in the 3-year-old?

Preliminary Results

Training. The results of the training sequence indicate that the MTS task posed no great challenge at any of the age levels studied. Even the 3-year-old children readily learned the basic task, and they succeeded in choosing the correct matching stimuli despite the use of very attractive "distractors." (A separate grotp of preschool youngsters had selected the distractors for this study by indicating the picture they "liked best.")

In brief, responding on the basis of either position or preference was rare. These findings contrast with those of Study and also with the many reports in the literature describing the difficulty that 5-year-old children have in acquiring a match-to-sample set. The importance of stimulus salience and cueing procedures cannot be overemphasized.

Auditory preference. As in Study 1, the majority of the first 110 Ss in the present investigation showed initial auditory preference. The setting condition (auditory or visual practice) had the expected effect for one trial only, indicating that stimulus modality is a more potent influence than setting events.

A few of the Ss (N=7) showed marked visual dominance accompanied by an inability to shift to the auditory mode. An attempt is now being made to find more children who show this unusual and intriguing response pattern so that the phenomenon, its correlates and implications can be studied.

Age. With the increased salience of the visual cue, more of the younger Ss in Study 2 than in Study 1 were able to ignore the auditory stimulus and shift to the visual mode when directed to do so. To oversimplify, it appeared that the "auditory capture" noted in 4-year-olds in the initial study was pushed back to the third year level by basic modifications in procedure.

It should be noted, however, that although many of the younger children were able to shift to the visual mode, they still required more practice trials than 5-year-olds. Also, in many cases the shift was more "fragile" at the younger ages and often persisted for only one or two uninstructed trials.

An incidental finding is that children who verbalize spontaneously (only about 15% of the sample) are able to shift successfully to either mode in either order. The interesting thing here is that the relationship between verbalization and ease of shifting holds even when the incorrect contingency is verbalized.

Other children use motoric rather than verbal mediators to regulate their modality choice. Some put their hands over their ears when instructed not to listen. When told to listen but not to look, they put their hands over their eyes or turn their bodies away from the stimulus display--and then "peek" before making the correct choice. These motoric patterns appear to function as self-cueing devices, helping the children remember which stimulus is to be ignored.

Ethnic differences. While there was a suggestion of ethnic differences in Study 1, no differences appeared in the present study with the improved stimulus displays and the reliance on supplemental cueing. Again, no support was found for hypotheses of relative auditory inefficiency or visual preference or dominance in ethnic minority youngsters.

Concept matching. The results of the concept and the exact match conditions were identical, even with the younger subjects. This finding decreases the likelihood that the auditory dominance found in the initial study resulted from the fact that the visual match was actually much more difficult than the auditory-to-visual match.

STUDY 3

Twenty autistic children, ages 4 to 11 (Mean = 7.3), were tested using the basic procedures developed in Study 1 and described in the appendix. The major difference here was that a somewhat more extensive and more flexible training series was used to allow as many as possible of these atypical youngsters to learn the task, despite their idiosyncratic behavior patterns.

Almost half (N = 9) of the children tested showed no evidence of acquiring the appropriate task set during the training sequence. All of these did, however, respond by touching one or more of the comparison stimuli, indicating some comprehension of the general--but not the specific--task. All but one child showed position habits, touching the center panels on almost every trial. This failure to understand the task itself was expected, of course, and these children were given subsequent training sessions, over several days, to explore methods of teaching them to do MTS problems.

Our expectation of marked individual differences in acquiring the MTS response pattern was also confirmed. One child "got it" after a series of imitation trials. Three others showed no improvement after imitation training but acquired the set rather easily after a graded series of visual tasks, beginning with single stimuli and shading in the distractors. They also acquired the auditory MTS response, following a pair-and-fade procedure. The remaining children showed only partial acquisition of the MTS set. Many of them would meet a 5-of-6 criterion and subsequently return to a position-guided habit. These reversions or losses seem to be further examples of the ubiquitous "attention lapse" problems of autistic children. In almost every instance the set could be recovered by repeating a few trials from the training sequence.

Examination of individual training protocols and clinical records suggests there are fairly marked correlations between these protocols and other measures of attention, response stereotypy and concept acquisition. Testing the strength of these associations will await a larger sample.

The data from the other half of the sample, those who did acquire the task set during training, are equally fascinating. The majority (N = 8) of these children chose auditory matches on the conflict trials and did not switch to visual choices on the shift tests. Inasmuch as this study used the visual training procedures of Study 1, the high incidence of auditory choices was surprising. Both the research literature and extensive clinical data available on autistic children suggest that they "tune out" auditory stimuli. Often, in fact, they are mistaken for deaf children. Yet in this situation, even with visual training and priming, they respond to the auditory cue. In essence their response patterns resembled those of normal children of younger chronological age. The remaining few children (N = 3) chose visual matches and, like their counterparts, did not shift their response patterns after priming or after instructions.

Evidently, whatever response the autistic child first uses on the conflict trials is likely to persist. If he is responding to the auditory cue, he is likely to continue doing so in the face of changing contingencies. The same is true if he is responding to positional or visual cues. In explaining this behavior, one could hypothesize a narrowed range of cue utilization in the autistic child. A second but related hypothesis is that he simply does not comprehend either the "shift cues" or the verbal instructions. A final hypothesis would attribute this response style to negativism in the child. That is, one could assume that if the child performs correctly on the unimodal trials, he does understand the instructions but does not comply. For a number of obvious reasons, the former hypotheses better meet criteria of parsimony.

To recapitulate, a few tentative conclusions emerge from the data collected to date. First, there is little support for the hypothesis that autistic children show visual preference patterns. Among those who did acquire the task set during regular training, the majority chose auditory matches. Secondly, whether a child chose auditory or visual matches, he was likely to persist in his initial mode and was unresponsive to attempts--whether by prompting, priming-reinforcement, or verbal instructions--to induce a modality shift. This response stereotypy seems better attributed to perceptual styles or failure of comprehension than to negativism.

STUDY 4

Replication with behavioral console.

As reported earlier, the console required several alterations before performing to specification. Moreover, we have subsequently made minor modifications in its design, one of which provides separate control of illumination for each response panel. This type of modification should facilitate the training procedures for both autistic and retarded children, as well as very young, normal children.

We have conducted a replication of Study 1 with the console, using normal Caucasian youngsters ages 4 and 5. Although the experimental sequence paralleled that of the initial study, the findings paralleled those of Study 2 (summarized above) with remarkable exactness. It is now apparent that the increased salience of the visual stimuli facilitates the transfer of the task set but does not affect the initial strength of the auditory cue. Preparation of a report for publication will be delayed until data for atypical youngsters can be included and compared.

The console now exists as a prototype and can, if needed, be duplicated for use by others. Our intent is to employ it in a series of studies on information processing over the next 2 years. At the end of that time we hope to design its successor, a smaller, more reliable instrument that would be economically feasible for use in educational settings as well as research laboratories.

In summary, more than 300 children have been tested at six preschools and six elementary schools in Los Angeles and Orange Counties as well as several private facilities for atypical children or youngsters with learning difficulties. Continuing research contacts have been established in several shcool districts, and plans are being made for follow-up studies of the children tested in the past two years.

The present report has been confined to the analyses of specific task responses in young children. Verbalizations and other expressive responses have also been recorded. The research program will now expand to include studies of attention deployment, verbalization and affect, beginning with an analysis of the data already available.

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Appendix

INFORMATION PROCESSING IN AUDIO-VISUAL CONFLICT

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The question of whether there are "visual types," "auditory types" and "motor types" has consumed a significant amount of research energy since the time of Galton and Kraepelin (Barsch, 1971). Today we are witnessing a two-pronged resurgence of interest in specific modality functions. One focus is the delineation of hierarchical patterns of modality responding as a function of either stimulus variables (Madsen, Rollins, & Senf, 1970), developmental changes (Carterette & Jones, 1967) or individual differences (Kuffler, 1969). The other is the use of modality-oriented approaches to pinpoint specific cognitive and academic deficits. Recent studies of bisensory information processing in brain damaged (Deutsch & Schumer, 1970) and learning disabled children (Beery, 1967; Birch & Belmont, 1964, 1965; Katz & Deutsch, 1963) have yielded provocative hypotheses about audio-visual integration and competence in modality shifting.

A particularly auspicious paradigm is one which places stimulus inputs from two sensory channels in conflict. A frequent comparison is between visual and haptic or proprioceptive cues, and the most common result is that vision "leads," "biases" or "captures" the other two senses (Hay, Pick, & Ikeda, 1965; Kinney & Luria, 1970). These findings are consistent with the oft-cited hypothesis that, between the ages of 5 and 7, there is a developmental shift from tactual to visual exploration or, in more general terms, from reliance on "near" to "distance" receptors (Fellows, 1968; White, 1965).

We know almost nothing, however, about developmental changes in the complex interplay between vision and audition, the two modalities most relevant for academic tasks. In the few perceptual studies of conflicting auditory and visual cues, vision has been named the leading channel here as well (Pick & Warren, 1969; Warren & Pick, 1970). In contrast, studies of recognition (Carterette & Jones, 1967) and recall (Dornbush, 1970) suggest that, at least at certain developmental levels, auditory functions are superior to the visual.

These findings underscore the importance of task-specific variables in the study of modality processes. Studies of memory would not necessarily be expected to show the same results as studies of usage. More importantly, most of the tasks used for comparative investigations of auditory and visual information processing were designed for adults and may be appropriate for children as young as 7 but rarely for preschool youngsters. Many of the stimuli are artificial and unfamiliar. Response requirements are relatively complex, and a functional understanding of concepts such as same-different may be assumed. Typically, when groups of children are compared, those of lower CAs (or MAs, reading scores, income levels, etc.) perform poorly on these tasks and it is difficult to pinpoint the reasons for their poor performance. "Deficit" in whatever ability is being assessed is only one possibility; such factors as failure to understand or remember instructions, inability to perform the indicator response (e.g., to imitate sounds) or general disinterest or avoidance are all probable contributors.

The present study was planned with concern for ecological validity and representative design as advocated by Egon Brunswick (1956). The stimuli and tasks were selected to be engaging to the children and reasonably analogous to those they encounter in daily learning situations. The conflict manipulation

was distortion-free; laboratory instruments such as prisms and pseudophones were not used. The intent was to develop a procedure for assessing specific modality competencies that is appropriate for preschool children and that minimizes some of the contaminating factors mentioned above. The basic component, a match-to-sample sequence, was trained and tested immediately before the start of the study, and task performance required only a simple motor response, touching a picture. Interest was maintained by the use of familiar pictures and labels (rather than shapes and tones) as well as noncontingent stickers and praise.

There is another major difference between the present study and many of those cited above: Here the memory load was minimal; the child made his choice in the presence of the visual sample and immediately following the auditory stimulus. The task dealt more with dimensions of "task set" than with memory or attention.

More specifically, each child was given a brief training series on a visual match-to-sample task, a practice series containing both visual and auditory problems presented separately, and then three bimodal conflict tests in which discrepant auditory and visual samples were presented simultaneously. The three tests of auditory and visual choices were conducted after unimodal practice, after a priming sequence designed to channel choices toward one modality, and during a series on which the child received direct instruction on each trial.

With bimodal presentations of discrepant stimuli, we can ask questions concerning the relative influence of each sensory mode under experimental conditions pertinent to early academic tasks. The main question asked is which stimulus modality exerts the greater influence on the child's choices? In more subjective terms, are children more likely to choose what they see or what they

hear, and is this modality choice related to developmental level? The second and third tests were arranged in order of increasing specificity of instructions (encouraging the child to choose the modality nonpreferred on the previous test). With this arrangement the effects of modality preference or dominance can be separated from -- and related to -- the effects of task-specific sets.

Methods

Subjects. The Ss were 99 children from two preschools and a kindergarten. Most were from low-income neighborhoods, and all major ethnic groups were represented. Two age groups separated by a 4-month interval were selected to facilitate identification of developmental changes. The 15 boys and 15 girls in the younger group ranged in age from 50 to 59 months ($\overline{X}$ = 55.1). The 34 boys and 35 girls in the older group were between 64 and 73 months ($\overline{X}$ = 68.0).

Stimuli. The visual stimuli were photographs of people, animals and common objects mounted on 3 x 5 inch cards. Each 14 x 22 inch display board contained three comparison cards in a row across the bottom, and those used in the Visual (V) and Bimodal Conflict (BC) series contained a fourth card, the sample, centered at the top. For the Auditory (A) series (and BC) the sample was a sound (cat meowing) or a label ("dog") presented by a tape recorder at a relatively low volume level (approximately 60 db against ambient noise ranging from 40 to 80 db).

Procedures. The Ss were run individually in an empty classroom by two female Es. The task, in all series to be described, was to match basic categories such as "trucks" or "horses." The child indicated his selection by touching one of the three lower cards. The modality content, position and latency of each response was recorded. Subsequently, a measure of delayed visual matching was administered to most of the Ss. The purpose of the present paper is to analyze the modality choice performance in the BC series.

Training. A shaping procedure was used to teach the match-to-sample set in the visual mode. The initial instructions were, "We have some pictures here and we'd like you to pick the ones that go together. We'll show you how to do it." The child was shown a display board with two picture cards at the bottom. E held up a third card, identical to one of the others. While saying, "See this one? Touch the one at the bottom" she brought the small card near the sample space on the board and affixed it. On the next trial, three match cards were used, and the same sample was held up and affixed. Three similar trials followed with different, already affixed samples and with alternations in the positions of the correct matches to discourage the establishment of position sets.

It should be noted that with the shaping procedure used during training the verbal instructions seemed unnecessary. They were included mainly because their absence would have been unusual and perhaps aversive. Verbal and manual prompts ("Just touch it." "That's perfect!" "Put your finger on the one that goes with it") were also used to encourage a hesitant child or correct an error. In those few cases when the child did not match correctly, without prompts, on four of the five training trials, three more trials were presented.

Practice series. Four V items similar to the Training items were then given, followed by eight A items. For the latter, the recorded sound and the display board were presented synchronously, just after the child was asked to "Listen, and find the one that goes with this." The A trials were succeeded by the final four V trials.

Pretesting with an independent sample had already indicated that auditory matches were highly probable at these ages and might occur exclusively unless the experimental procedures were designed to encourage visual choices. Since we hoped to start the experiment with approximately a 50-50 split in modality

choice, the content of the Training series (V only) and the sequence of the practice trials (4V, 8A, 4V) were planned to give the advantages of both primacy and recency to visual matches. Moreover, this advantage was further augmented by the identical physical appearance of the V and BC display boards.

Throughout the practice series, E instructed each trial using a highly redundant set of comments including, "OK, which one is the same this time?" "And which one goes with this?" "Now which one is like this?" The wording was varied so that formation of the appropriate problem set would not be dependent on the child's understanding of a concept such as "same."

Bimodal conflict. The child received no new instructions and no warning of a change in procedure at the start of this series. Initial modality preference was determined by a child's responses on the first four trials (the Initial BC test). Discrepant A and V sample stimuli were presented simultaneously. One of the response alternatives matched the V sample, one matched the A sample, and the other matched neither. For example, as the child heard the word "dress" he was presented with a display board containing a picture of a lamp in the position of the sample. His three comparison stimuli were a different lamp, a globe and a dress.

Each response was scored as either Visual, Auditory or Distractor. Occasionally S started to indicate one card and then switched to another; these "self-corrects" were allowed and scored according to the child's final choice.

The next four trials comprised the Prime sequence, a series of unimodal cards intended to serve as a relatively subtle attempt to shift the child's response set away from that shown on the Initial BC test. If a child made more V than A responses on this first test, he was assigned to Prime-A which consisted of four trials on which the samples were labels only; no V samples were given. If a child showed a preference in the opposite direction or an

equal split, he was assigned to Prime-V and received four V items for which no A match was possible.

Two BC items were then given to assess whether or not the priming had shifted the child's response modality. Each trial was scored 1, indicating a shift, or 0. The question, "Did he shift?" was answered "Yes" if the child obtained a total score of 2. To insure appropriate classifications, Ss who scored 1 were given one or two additional trials until they attained either two A or two V responses.

In the final or Directed Shift phase, an intensive effort was made to shift the child from one modality to the other. Children who had given A responses on the Primed Shift test were told before each trial, "This time, look, don't listen. Look at the one at the top and pick the one that goes with it. Remember now, just look." The parallel instructions for children who tended to give V responses were, "This time, listen, don't look. Pick the one that goes with this. Remember now, just listen." These Directed Shift trials comprised the third BC test.

Except during the training series, a noncorrection procedure was used. Praise and encouraging comments (e.g., "You've got the idea") were given frequently. In addition, each child received a colorful sticker chart. The stickers were given noncontingently at predetermined intervals during the training, practice and priming sequences and never during a test series. These reinforcers were intended to maintain the child's interest and alertness rather than to provide him with information about his test performance.

Results

Figure 1 presents an overview of the experimental procedures and the data from all three test phases. Results of the Initial BC test showed a marked age difference in modality choice. The majority of the older children (59%)

selected V matches, while very few of the younger children (13%) chose to match

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Insert Figure 1 about here

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the V stimuli ($X^2 = 16.10$; $p<.001$). It is clear that the primacy and recency of the V trials in the training-practice series did not discourage A responding in the younger Ss.

On the Primed Shift test, most of the children exposed to Prime-A (78%) shifted to the auditory mode, while only 2 of the 54 children given Prime-V shifted to the visual mode ($X^2 = 54.42$; $p<.001$). This effect of modality was significant within both the younger and older groups ($p_e = .001$ and $X^2 = 30.69$, $p<.001$ respectively) and shows the greater probability of shifting into the A mode. The younger Ss were less likely to shift than older Ss ($X^2 = 12.15$; $p<.001$), but this effect is almost totally redundant with the modality effect in that most of the younger Ss tended initially to give A responses and thus were exposed to Prime-V.

As shown in the lower portion of Figure 1, most of the children (88%) were given V instructions during the Directed Shift trials. Sixty-two percent of these Ss were those who were in the Prime-V condition and did not shift on the Primed Shift Test. For these "second try" children, the explicit instructions represented an additional experimental attempt to effect a shift to the visual modality. The remaining 38%, indicated on the left side of Figure 1, showed V choices initially and shifted successfully to the A mode after Prime-A. In other words, this group had already demonstrated one successful shift and the function of the explicit instructions was to encourage a second shift, this time back to the originally preferred modality. The indications of "Yes" and "No"

in this portion of Figure 1 are based on a criterion of 3 responses in the instructed mode.

A more detailed view of scores on the Directed Shift trials for Ss receiving V instructions can be seen in the percentage distributions of Figure 2. As shown on the graph, children who shifted to the A mode after

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Insert Figure 2 about here

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priming were also more likely to show V responses here, while those who did not shift after priming were unlikely to do so under explicit instructions. A Kolmolgorov-Smirnov Test (Siegel, 1956) shows the cumulative distributions to be significantly different ($D = .531$; $p<.001$).

The same analysis was done within the older group. The results were identical to those of the total sample: Older Ss exposed to Prime-A, for whom this was a second shift, were much more likely to achieve a shift on this third test than were their Prime-V counterparts who showed no previous shift ($D = .428$; $p<.001$).

Only 10 of the 45 children who were exposed to Prime-A did not shift on the subsequent probe trials, and only 2 of the 54 children who received Prime-V succeeded in shifting. This group of 12 Ss was given auditory instructions during the Directed Shift sequence, but the N is too small for meaningful analyses of subgroup patterns. Eight of these children failed to shift on the Directed Shift test, and there was no detectable relationship between performance on this third test and initial response mode.

It should be noted that some children did not show an unambiguous modality preference on the Initial BC test; 16% of the Ss made fewer than three out of four choices in a single modality. Those children in this "indeterminate"

subgroup who showed a 2:1 split favoring the visual mode were assigned to Prime-A. All of the others in this subgroup, i.e. those with either a 2:1 split in the opposite direction or an equal split, were assigned to Prime-V. Examination of individual records showed that most of these Ss, 11 of whom were in the younger group, seemed to be making position-guided rather than modality-guided responses. As a cautionary measure, all data analyses reported above were repeated without these Ss, even though position habits were almost always broken by the Prime condition. The pattern of findings was identical to that of the total sample: More older than younger Ss made initial V choices ($X^2 = 13.82$; $p<.001$); more children who initially gave V responses, compared to those who initially showed A choices, changed preferences on the Primed Shift test ($X^2 = 43.23$; $p<.001$); and successful shifts to the visual mode during the Directed Shift condition were more probable for those who had responded correctly to the Prime condition than for those who had not ($D = .587$; $p<.001$). The latter two differences were found within the older group alone as well as for the total sample.

Discussion

A major finding was the consistent dominance of the auditory stimuli; there were more A than V responses under all experimental conditions. To summarize the specific results: More older than younger children matched to the visual standard initially; unimodal priming was more effective in increasing shifts to the auditory mode than to the visual mode; and children who had already shifted modalities once were more likely to succeed at ignoring a competing stimulus and shifting to the visual mode than were children who made no prior shift.

The most plausible interpretation of these data combines the notions of "auditory capture" and malleability of "task set." It is suggested that

4-year-olds make few visual choices because at this age level auditory stimuli have an apparently obligatory quality that cannot be ignored. Many older children, in contrast, are more competent at resisting the effects of intrusive (auditory) stimuli.

The strength of the auditory capture was evident in several aspects of the response protocols. The vast majority of "self-correct" responses were those where the child started to choose the visual stimulus and then immediately switched to the auditory match. Also, on the Primed Shift and Directed Shift tests, many Ss made only one visual selection, on the first trial, and then consistently chose auditory matches. The spontaneous verbalizations of children who were not able to make the directed visual matches further indicated the tenacity of the auditory "hook." After receiving the instructions, many overtly agreed not to listen and even placed their hands over their ears, demonstrating their comprehension of and attempts to follow the directions. When one of these children was later asked why he chose the auditory match he replied, "I can hear through my fingers."

It is further suggested that the developmental difference was a function at least in part of the 5-year-old's more malleable task set or his greater ability to modulate his performance in accord with changing environmental, particularly social, cues. It will be recalled that the training and practice sequences were programmed to favor the visual mode and that more than half of the older children (in contrast to only 13% of the younger ones) chose visual matches during the initial test trials. It seems reasonable to hypothesize that the fifth year is a transitional stage between reacting in an obligatory manner to competing auditory stimuli and inhibiting this reactivity in response to the demands of the experimental or academic task. Flexibility was particularly apparent in the ability of some of the 5-year-olds to ignore the verbal

label during the Directed Instruct-V series even after being encouraged to respond to the labels in the immediately preceding Prime sequence. This interpretation is consistent with developmental theories of progressive increases in a child's ability to decenter, to inhibit or to disregard irrelevant information (e.g., Gibson, 1969; Kagan, 1967; White, 1965).

A critical determinant of the 4-year-old's susceptibility to auditory capture may be his rudimentary language competence. Yakovleva (1958; cited in Luria, 1969) found that, when a balloon is placed in a 2-year-old's hand and it is suggested that he squeeze it, he does so easily. However, when he is told "Don't squeeze" the child squeezes even harder than before hearing the message that was intended to inhibit. The interpretation posed by Luria and his colleagues (1969) is that speech has a nonspecific excitatory function at this age which facilitates the dominant action; language does not serve a selective regulatory function until approximately age 5.

The present paradigm is a more advanced analogue of an on-off motor task. It is probable that matching to the auditory sample, like squeezing the balloon, is a dominant response. Despite the intentions of the speaker, the negative message cues the response that is at the top of the hierarchy. In other words, the instructions serve a general impelling function rather than a specific regulatory role. It is particularly noteworthy that failure to inhibit responses to the auditory sample occurred frequently even though the negative message ("Don't listen") was accompanied by a positive alternative ("Look at the one at the top; find the one that goes with it").

There are at least two other plausible interpretations of the present findings that cannot be rejected entirely on the basis of this initial study. One is that the developmental differences were simply due to task complexity;

the visual match required extra encoding and may therefore have been more difficult. This interpretation is weakened, however, by the failure to find significant differences in difficulty between either the visual and auditory Practice series or the visual and auditory Priming trials. The results indicate that the match-to-sample task in either modality alone was relatively unchallenging even for the 4-year-old Ss.

Another possibility is that the results reflect an intrasubject rather than a developmental variable. Perhaps there are "auditory learners" and "visual learners," the latter being more flexible in response to changing task demands. Despite the longstanding popularity of this notion, recent studies of adults have failed to find consistent modality preferences or superiorities on perceptual or memory tasks (e.g., Jensen, 1971). Still, it is conceivable that a modality preference might interact with age, with children shifting at different rates and in different ways from auditory to visual "dominance" as academic tasks progressively emphasize visual processes. To test this hypothesis, a study is in progress in which auditory rather than visual setting conditions are instituted with groups of 4-, 5-, and 6-year-old children.

Implications. In addition to generating information applicable to theories of perceptual-cognitive development, studies using the present paradigm may contribute toward our understanding of specific learning disabilities. Recent investigations indicate that poor readers have difficulty when intermodal, particularly audio-visual, information processing is required (Beery, 1967; Birch & Belmont, 1964, 1965; Katz & Deutsch, 1963). In tasks involving recall of bimodal stimuli, Senf and his colleagues (Senf, 1969; Senf & Freundl, 1971) noted auditory preferences in learning disability Ss but not in the normal control groups and suggested the possible roles of auditory distraction, auditory dominance and conditioned avoidance responses to visual stimuli.

Further study of these modality processes, using a task such as the present one which carries only a very light memory load, would help localize specific areas of competence as well as deficit in children experiencing academic difficulties.

Studies of auditory and visual information processing such as those cited above point to the possibility of using tests of modality preference, dominance and integration to assess readiness (particularly for reading) at the kindergarten level. Jensen underscores the dangers of "...forcing instruction on a child who is still far from his optimal readiness for the subject of instruction" (1969, p. 15). One obvious reason is that repeated early failure may cause a child to "turn off" academic learning experiences. A more insidious danger is that he may develop partial strategies that allow him to perform adequately on specific classroom tasks without learning the intended material. For example, a child still prone toward auditory capture may have no noticeable difficulty on a visual matching task aimed at teaching the correspondence between upper and lower case letters of the alphabet. He may, however, make his selections solely on the basis of the teacher's verbal cues, ignoring the relationships among the visual stimuli. The deficiency may remain undetected for several years, perhaps until classroom tasks become predominantly visual. Discovered at age 8, such a maladaptive learning strategy is much more difficult to correct than if detected -- or prevented -- at age 5 or 6.

There is quite another implication of the present results, namely, that the consistent auditory preferences of the younger children be viewed as a type of strength rather than a relative deficit. To paraphrase Sigel & Olmsted (1970), there is a great need to map the perceptual and cognitive abilities, particularly of disadvantaged children, that are of unknown correlation with g but that may be used to educational advantage. A child's consistent preference for auditory

tasks (and his delight in recorded stimuli) could be harnessed in the development of fruitful curricular programs.

There is also a methodological point to be made. Several investigators have postulated that some form of "relative auditory inefficiency" characterizes low-income or minority group children, and that this deficit may be related to reading and more general cognitive retardation. Riessman (1967), for example, suggests that the "culturally deprived" child is a visual rather than auditory learner and that visual modality styles conflict with the demands of the typical classroom and result in deficient academic performance. In the present investigation, children from predominantly low-income neighborhoods had no difficulty performing auditory tasks involving common sounds and, when given a choice, tended to "prefer" verbal labels to pictures. While the present study was not intended to assess ethnic differences, there indeed was a tendency for Black Ss to make fewer visual choices than Ss from other ethnic groups. In the light of deficit hypotheses regarding auditory discrimination and learning (e.g., Deutsch, 1964), the present findings underscore the importance of contextual or procedural variables and the dangers of generalizing from specific experimental results to general concepts such as relative auditory inefficiency. Zimiles' lucid comments regarding the need for process-oriented evaluation of compensatory education are apropos here: "This stance changes the task of studying conceptual functioning (and other aspects of cognition as well) from an emphasis on determining the presence-absence of a particular concept to an analysis of the conditions under which it is available for use" (1970, p. 241).

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Figure Captions

Figure 1. Flow chart of experimental procedures and summary of results. On the Initial BC test, V indicates Ss who showed more visual than auditory choices and were assigned to the Prime-A condition, while A indicates Ss who showed auditory or equal preferences and were assigned to Prime-V. The dashed vertical lines in the lower portions separate Ss who did shift after the prime sequence from those who did not.

Figure 2. Percentage distributions for Ss given Visual instructions on Directed Shift trials. Shaded areas represent younger Ss.

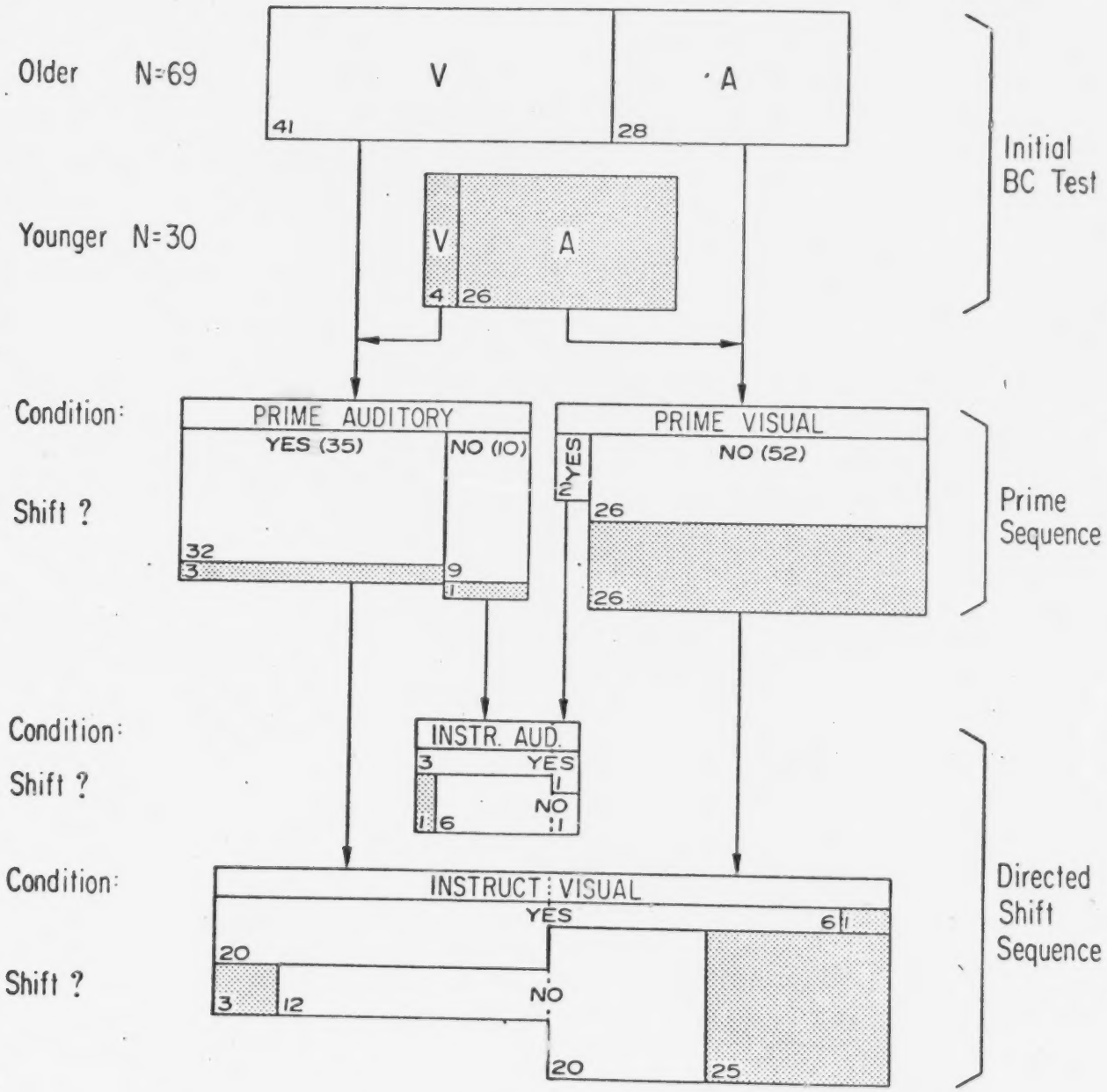
Older N=69
V
A
41
28
Initial BC Test
Younger N=30
V
A
4
26
Condition:
PRIME AUDITORY
YES (35)
NO (10)
PRIME VISUAL
YES
NO (52)
Shift ?
32
3
9
1
26
26
Prime Sequence
Condition:
INSTR. AUD.
3
YES
1
NO
1
6
1
Shift ?
Condition:
INSTRUCT. VISUAL
YES
6
1
20
Shift ?
3
12
NO
20
25
Directed Shift Sequence

Figure 1

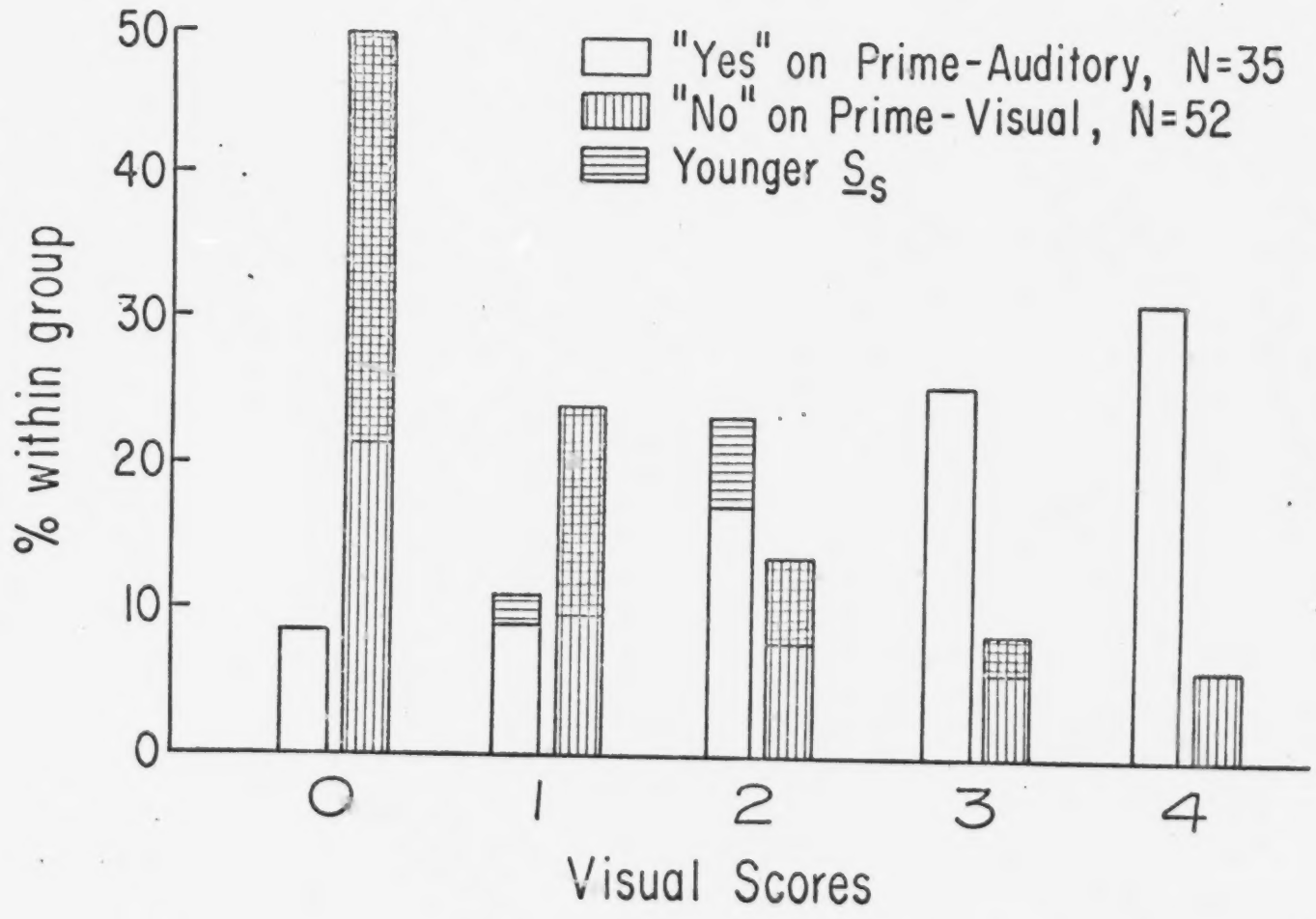
"Yes" on Prime-Auditory, N=35
"No" on Prime-Visual, N=52
Younger Ss
% within group
50
40
30
20
10
0
0
1
2
3
4
Visual Scores

Figure 2